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# ANTIAIR WARFARE DEFENSE OF SHIPS AT SEA

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SLIDE 1 ON

GOOD MORNING, LADIES AND GENTLEMEN. FOR THE LAST SEVERAL YEARS I HAVE BEEN INVOLVED IN A NUMBER OF STUDIES AND ANALYSES CONCERNING NAVAL ANTIAIR WARFARE. IN SUCH EFFORTS WE OFTEN CONCENTRATE ON A PARTICULAR FACET OF THE AAW PROBLEM OR A PARTICULAR PIECE OF EQUIPMENT. IT'S, THEREFORE, VERY EASY TO GET MYOPIC OR DEVELOP TUNNEL-VISION--AS THE CLICHÉ GOES, WE MAY LOSE THE FOREST AMONGST ALL THE TREES.

TODAY, OUT OF BOTH CHOICE AND NECESSITY, I AM GOING TO TRY NOT TO BE SPECIFIC ABOUT PARTICULAR PIECES OF EQUIPMENT. I'M NOT GOING TO TELL YOU HOW GOOD OR BAD AN F-14 OR AN AEGIS SYSTEM IS. WHAT I WOULD LIKE TO DO IS DISCUSS AAW DEFENSES IN GENERAL. I'LL NAME DROP A BIT, BUT MY REAL PURPOSE IS TO GIVE YOU A BROAD PERSPECTIVE ON THE AAW PROBLEM--NOT NECESSARILY THE ONLY PERSPECTIVE, BUT ONE THAT I THINK IS HELPFUL.

I WILL ALSO BE TALKING OF DEFENSE IN ITS MOST COMMON INTERPRETATION. I AM GOING TO IGNORE SO-CALLED "BEST DEFENSE IS A GOOD OFFENSE" NOTIONS, AND TALK ONLY ABOUT REACTIVE DEFENSE.

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AS ANOTHER CAVEAT, LET ME SAY THAT AS I PREPARED THIS TALK, I WAS THINKING OF THE DEFENSE OF U.S. NAVY SHIPS AT SEA BY U.S. NAVY FORCES. THUS, FOR EXAMPLE, I WASN'T CONSIDERING THE USE OF AIR FORCE AIRCRAFT TO HELP DEFEND SHIPS. I DON'T BELIEVE THIS AFFECTS ANYTHING THAT I WILL SAY, BUT I WANT US TO START OUT ON THE SAME BASIS.

SLIDE 1 OFF

SLIDE 2 ON

I'D LIKE TO ACCOMPLISH THESE TWO THINGS: PRESENT THE BROAD OVERVIEW I JUST MENTIONED, AND, ALONG THE WAY, TRY TO IDENTIFY A NUMBER OF CRITICAL PROBLEMS THAT AAW DEFENSE PRESENTS TO US.

SLIDE 2 OFF

SLIDE 3 ON

BEFORE TURNING TO ANTI-AIR WARFARE, LET'S CONSIDER THE GENERAL PROBLEM OF DEFENSE--WHETHER AGAINST AIRPLANES, SHIPS, SOLDIERS, OR INVADERS FROM SPACE. I THINK IT'S USEFUL TO BREAK THE DEFENSIVE PROBLEM DOWN INTO THESE FIVE FUNCTIONS.

FIRST OF ALL, THE DEFENDER MUST DETECT THE PRESENCE OF AN ATTACKING FORCE. TRADITIONALLY THIS HAS BEEN THE FUNCTION OF SCOUTS AND SENTRIES. AS THIS CENTURY HAS PROGRESSED WE'VE FOUND IT NECESSARY TO GO TO MORE SOPHISTICATED METHODS OF DETECTING--

RADARS, SONARS, INFRA-RED SENSORS, AND THE LIKE. THE PURPOSE OF THESE DETECTION SYSTEMS IS TO TELL THE DEFENDER WHERE AND WHEN TO EXPECT AN ATTACK. HOWEVER, THIS INFORMATION IS USELESS, UNLESS IT IS RECEIVED IN TIME FOR THE DEFENDER TO REACT EFFECTIVELY. A SOLDIER WHO DOESN'T DETECT A SNIPER UNTIL HE HEARS A RIFLE SHOT IS NOT LIKELY TO REACT IN TIME.

IF THE DEFENDER DETECTS THE ATTACKER, REACTS IN TIME TO GET IN A DEFENDING POSITION OR POSTURE, HE STILL MUST HAVE A WEAPON WHICH WILL BE EFFECTIVE. THE WEAPON MUST HAVE THE RANGE, SPEED, ACCURACY, AND LETHALITY TO DEFEAT THE ATTACKER. A RIFLE IS UNLIKELY TO HAVE THE RANGE OR LETHALITY TO DEFEAT A TANK. IF THE RIFLE HAS A MISALIGNED SIGHT IT IS UNLIKELY TO DEFEAT EVEN AN OPPOSING SOLDIER.

THESE FIRST THREE FUNCTIONS ARE THE BASIC MECHANICS OF ANY DEFENSIVE SYSTEM. WE SPEND A LOT OF TIME AND RESOURCES SEEKING TO IMPROVE OUR CAPABILITY TO DETECT, REACT, AND USE WEAPONS EFFECTIVELY AGAINST AN ATTACKER. BUT SOLUTION OF THESE FIRST THREE FUNCTIONS DOES NOT IMPLY WE HAVE AN EFFECTIVE DEFENSE.

SINCE MOST ATTACKS ARE BY MULTIPLE ATTACKERS, THE DEFENSE MUST BRING ENOUGH WEAPONS TO BEAR TO SUCCESSFULLY REPEL OR DEFEAT THE ENTIRE ATTACK. THIS IS THE FAMILIAR MILITARY RULE OF MASSING FIREPOWER. WE MUST HAVE ENOUGH DEFENDERS IN THE RIGHT POSITION.

FINALLY, WE MUST BE ABLE TO DEFEND AS MANY TIMES AS NECESSARY--UNTIL THE ATTACKERS ARE EXHAUSTED, OR UNTIL WE ARE NO LONGER IN HARM'S WAY. THIS INVOLVES BEING ABLE TO ABSORB SOME ATTRITION OR DAMAGE TO THE DEFENSES, AND HAVING SUFFICIENT SUPPLIES--FOR EXAMPLE, BULLETS--TO CONTINUE THE DEFENSE SUCCESSFULLY AGAINST EACH SUCCEEDING ATTACK. IT IS THIS LAST FUNCTION OF DEFENSE THAT IS OFTEN OVERLOOKED.

A NOTE ON THESE FUNCTIONS--ALL REPRESENT PROBABILISTIC EVENTS. NOTHING HAPPENS WITH CERTAINTY. THIS MEANS SIMPLY THAT THERE ARE NO PERFECT DEFENSES.

AS I SAID BEFORE, THESE ARE FUNCTIONS OF ANY DEFENSE SYSTEM. THINK OF SOLDIERS DEFENDING A FORT OR ESCORT SHIPS DEFENDING A CONVOY.

SLIDE 3 OFF

SLIDE 4 ON

HERE IS A SIMPLER WAY OF EXPRESSING THIS IDEA. THE DEFENSIVE MISSION IS A HIERARCHY OF THREE DEFENSIVE FUNCTIONS: DEFEND AGAINST AN ATTACKER; DEFEND AGAINST MANY ATTACKERS; AND DEFEND AGAINST REPEATED ATTACKS. BEFORE WE CAN DEFEND AGAINST MANY

WE MUST SOLVE THE DEFENSIVE PROBLEM OF ONE ATTACKER. SIMILARLY, WE MUST BE SUCCESSFUL AGAINST MANY ATTACKERS IN A SINGLE RAID IN ORDER TO ACHIEVE SUCCESS AGAINST REPEATED ATTACKS.

THE MANNER IN WHICH WE SOLVE ANY OF THESE DEFENSIVE FUNCTIONS AFFECTS OUR CAPABILITIES IN THE SUCCEEDING FUNCTIONS. OUR DEFENSIVE SYSTEM IS NOT COMPLETE WITHOUT ATTENTION TO ALL THREE FUNCTIONS; BUT THEY MUST BE ADDRESSED AND SOLVED SEQUENTIALLY.

NOW LET'S TURN TO AAW DEFENSE.

SLIDE 4 OFF

SLIDE 5 ON

FIRST, WHAT TYPE OF THREATS OR ATTACKERS ARE WE PRIMARILY CONCERNED WITH. NOT VERY MANY YEARS AGO, THE AIR THREAT WAS FROM AIRPLANES ARMED WITH BOMBS, ROCKETS, TORPEDOES, OR GUNS. MANY OF THE AAW SYSTEMS WE NOW HAVE IN THE FLEET WERE INITIALLY DESIGNED TO DEFEND AGAINST THAT TYPE OF THREAT.

TODAY, WE COMMONLY THINK OF THE MAJOR THREAT AS BEING MODERATE TO LONG RANGE MISSILES THAT MAY BE FIRED FROM A VARIETY OF LAUNCH PLATFORMS--AIRCRAFT, SHIPS, SUBMARINES, AND EVEN LAND-BASED LAUNCH PADS. AIRCRAFT REMAIN A REAL THREAT, BUT MORE AND MORE BECAUSE OF THEIR CAPABILITY TO CARRY MISSILES.



THE MISSILE THREATS TODAY ARE SMALL, FAST TARGETS THAT STRESS OUR PRESENT SYSTEMS. IN THE FUTURE OUR DEFENDING SYSTEMS WILL BE GETTING BETTER, BUT SO WILL THE ATTACKERS. WE EXPECT MISSILES TO BE MUCH MORE CAPABLE. THEY WILL HAVE LONGER RANGE, NEW AND VARIED GUIDANCE MODES, AND A WIDE VARIETY OF TRAJECTORIES. IN ADDITION THEY WILL BE SUPPORTED BY MORE INTENSE JAMMING OF OUR DETECTION SYSTEMS AND OUR COMMUNICATION SYSTEMS. (IN TERMS OF OUR PREVIOUS DISCUSSION WE CAN CONSIDER COMMUNICATIONS AS PART OF OUR REACTION SYSTEM.)

IN SUMMARY, A PRESENTLY STRESSFUL SITUATION IS APT TO REMAIN STRESSFUL.

SLIDE 5 OFF

SLIDE 6 ON

WHAT DO WE HAVE TO DEFEND AGAINST THESE THREATS? WE HAVE SEVERAL TYPES OF DEFENSES. THERE ARE SO-CALLED HARD-KILL DEFENSES THAT TRY TO ACTUALLY DESTROY THE TARGET. THERE ARE THREE LAYERS OF HARD-KILL DEFENSES: THE OUTER-AIR DEFENSE THAT CONSISTS OF FIGHTER AIRCRAFT; AREA DEFENSES PROVIDED BY SURFACE-TO-AIR MISSILE, OR SAM, BATTERIES ON SHIPS; AND POINT DEFENSES WHICH ARE SHORT-RANGE MISSILE AND GUN SYSTEMS FOR TERMINAL DEFENSE ON EACH SHIP.

AGAINST AIR-LAUNCHED ATTACKS ALL THREE LAYERS OF DEFENSE CAN BE APPLIED. AGAINST MISSILES LAUNCHED FROM SHIPS OR SUBMARINES IT IS LIKELY THAT THE BRUNT OF THE DEFENSIVE EFFORT WILL BE BORNE BY THE AREA AND POINT DEFENSES ALONE.

A SECOND TYPE OF DEFENSE ARE THE SO-CALLED SOFT-KILL DEFENSES. THESE ARE COUNTERMEASURES, OFTEN ELECTROMAGNETIC IN NATURE, THAT ATTEMPT TO CONFUSE THE ATTACKER. TWO KINDS ARE OFTEN DISCUSSED: THOSE THAT SEEK TO AVOID ATTACK OR DELAY THE ATTACK--IN OTHER WORDS HIDE THE FORCE FROM THE ATTACKER. JAMMING OF RADAR SYSTEMS IS AN EXAMPLE OF THIS. THE SECOND KIND SEEKS TO CONFUSE THE TERMINAL GUIDANCE OF ATTACKING MISSILES--THAT IS, THEY ATTEMPT TO DECOY MISSILES AWAY FROM THEIR INTENDED TARGETS.

THESE SOFT-KILL DEFENSES MAY BE THE MOST IMPORTANT OR MOST EFFECTIVE OF ALL OUR DEFENSIVE SYSTEMS. HOWEVER, THEY ARE FAIRLY COMPLEX AND I WILL NOT DISCUSS THEM TODAY. I'LL CONCENTRATE ON THE HARD-KILL DEFENSES.

I'LL DISCUSS THE THREE TYPES OF HARD-KILL DEFENSES IN TURN--DISCUSSING EACH IN TERMS OF THE THREE HIERARCHIAL FUNCTIONS OF DEFENSE IDENTIFIED PREVIOUSLY--DEFENSE AGAINST AN ATTACKER, DEFENSE AGAINST MANY ATTACKERS, AND DEFENSE AGAINST REPEATED ATTACKS.

SLIDE 6 OFF

SLIDE 7 ON

IF THE DEFENDING NAVAL FORCE CONTAINS AIRCRAFT CARRIERS THEN THE FIRST LAYER OF AAW DEFENSE IS THE OUTER-AIR DEFENSE. THE PURPOSE OF THIS DEFENSE IS TO DILUTE THE MISSILE ATTACK AND PREVENT REPEATED ATTACKS. THEY DO THIS BY DESTROYING ENEMY BOMBERS TRYING TO LAUNCH MISSILES AGAINST THE FORCE. DESTROYING ENEMY AIRCRAFT PREVENTS OR REDUCES REPEAT ATTACKS BY LOWERING THE INVENTORY OF BOMBERS--THE FEWER THERE ARE, THE LESS OFTEN THEY'LL COME BACK. TO ACHIEVE THIS END, IT DOESN'T MATTER WHEN BOMBERS ARE KILLED--BEFORE OR AFTER THEY LAUNCH THEIR MISSILES. TO DILUTE THE MISSILE ATTACK THOUGH, BOMBERS HAVE TO BE KILLED PRIOR TO THE MISSILE LAUNCH.

THE ELEMENTS OF THE OUTER-AIR DEFENSE ARE THE AIRBORNE EARLY WARNING AIRCRAFT SUCH AS THE E-2C, WHOSE PURPOSE IT IS TO DETECT THE ATTACKING BOMBERS AND DIRECT INTERCEPTORS, AND FIGHTER AIRCRAFT SUCH AS THE F-4 AND F-14, AND, IN THE FUTURE, THE F-18, WHOSE PURPOSE IT IS TO INTERCEPT THE ATTACKING BOMBERS.

FIGHTER AIRCRAFT ARE MAINTAINED IN TWO LOCATIONS. A FEW, KNOWN AS COMBAT AIR PATROL, OR CAP, AIRCRAFT ARE STATIONED A VERY SUBSTANTIAL DISTANCE FROM THE NAVAL TASK FORCE. OTHERS ARE MAINTAINED IN AN ALERT STATUS ON THE DECK OF THE AIRCRAFT CARRIER. THEY ARE CALLED DECK-LAUNCHED INTERCEPTORS, OR DLIs. IF DETECTION OCCURS EARLY ENOUGH, THE DLI AIRCRAFT MAY BE ABLE TO ASSIST THE CAP AIRCRAFT IN THE OUTER-AIR DEFENSE ZONE.

LET'S CONSIDER THE OUTER-AIR DEFENSES IN TERMS OF THE THREE HIERARCHICAL FUNCTIONS OF DEFENSE.

SLIDE 7 OFF

SLIDE 8 ON

FIRST LET'S CONSIDER THE PROBLEM OF DEFENSE AGAINST AN ATTACKER. THIS IS A GRAPHIC REPRESENTATION OF THAT PROBLEM. THIS TYPE OF DIAGRAM IS FAMILIAR TO MOST OF YOU--A TIME-RANGE PLOT. ALONG THE HORIZONTAL AXIS I'VE PLOTTED RANGE FROM THE CARRIER TASK FORCE OR BATTLE GROUP. ELAPSED TIME IS SHOWN ALONG THE VERTICAL AXIS. THE CURVE DEPICTS THE PATH OF AN ATTACKING AIRCRAFT. TIME IS BEING MEASURED FROM THE TIME THE TARGET IS DETECTED BY TASK FORCE SENSORS. IN THIS CASE THAT PROBABLY MEANS DETECTION BY AN E-2 AIRBORNE EARLY WARNING AIRCRAFT. THE ATTACKER FLIES TOWARD THE FORCE UNTIL MISSILE-LAUNCH RANGE IS REACHED, LAUNCHES HIS MISSILES AT THE TASK FORCE AND THEN RETIRES. THE MINIMUM RANGE ON THIS PATH IS THE MISSILE-LAUNCH RANGE.

THE DEFENDER'S PROBLEM IS TO INTERCEPT AND DESTROY THE BOMBER.

OVERLAY 1 ON

HERE I HAVE ASSUMED THAT A FIGHTER IS POSITIONED AT THE INDICATED RANGE FROM THE TASK FORCE. ONCE THE ATTACKER IS DETECTED A CERTAIN AMOUNT OF TIME ELAPSES BEFORE THE DEFENDING FORCE

RESPONDS. THIS IS INDICATED HERE BY THE REACTION TIME DELAY. THIS IS THE TIME IT TAKES THE DETECTION INFORMATION TO BE ASSIMILATED, A DECISION TO BE MADE, AND INSTRUCTIONS COMMUNICATED TO THE FIGHTER CHOSEN TO MAKE THE INTERCEPT. THE FIGHTER THEN FLIES AN INTERCEPT TRAJECTORY AS SHOWN. HERE HE'S LUCKY ENOUGH TO INTERCEPT PRIOR TO THE BOMBER'S LAUNCH POINT.

THIS SIMPLE DIAGRAM ILLUSTRATES ALL THE BASIC ELEMENTS OF DEFENSE AGAINST AN ATTACKER--DETECTION, REACTION, AND USING THE WEAPON EFFECTIVELY.

IT IS ALSO A USEFUL TOOL FOR SEEING WHAT THE ATTACKER CAN DO TO OVERCOME THE DEFENSE. FOR EXAMPLE, IF HE INCREASES THE LAUNCH RANGE OF HIS MISSILE, (SEE DASHED AIRCRAFT PATH)

#### OVERLAY 2 ON

THEN HE DOESN'T HAVE TO FLY AS CLOSE TO THE TASK FORCE--THE FIGHTER MAY NOT BE ABLE TO INTERCEPT HIM IN THAT CASE.

AS I MENTIONED BEFORE, THIS SIMPLE DIAGRAM IS EXTREMELY USEFUL IN IDENTIFYING THE PROBLEM AREAS IN DEFENSE. IF YOU HAVEN'T SPENT TIME PLAYING AROUND WITH THESE PLOTS--DO SO. BUT A CAVEAT. AS I MENTIONED BEFORE ALL DEFENSIVE FUNCTIONS ARE PROBABILISTIC IN NATURE. THIS IS NOT ILLUSTRATED IN THE DIAGRAM. A PERFECT DEFENSE IN OUR CHART WILL BE LESS THAN PERFECT IN REALITY.

SLIDE 8 OFF

SLIDE 9 ON

THE ATTACKER HAS A NUMBER OF WAYS OF ATTEMPTING TO REDUCE OUR OUTER-AIR DEFENSE EFFECTIVENESS. ALL OF THESE ARE DESIGNED TO REDUCE THE TIME AVAILABLE TO THE DEFENDER. MOST ARE OBVIOUS UPON INSPECTION OF THE PREVIOUS GRAPH. INCREASING STANDOFF RANGE, INCREASING HIS BOMBER SPEED, AND JAMMING OUR DETECTION SYSTEMS ALL REDUCE THE TIME IN WHICH WE HAVE TO REACT AND ENGAGE-- IN A COMMON MILITARY TERM--SHRINKS THE BATTLE SPACE OF THE DEFENDER.

ANOTHER TACTIC HE MAY HAVE IS TO RETAIN THE CAPABILITY TO ATTACK FROM ANY DIRECTION. THIS MEANS WE MUST BE PREPARED TO DEFEND ANY DIRECTION. THIS TENDS TO SPREAD OUR OUTER DEFENSES. HENCE, WHEN THE ATTACK DOES COME FROM A SPECIFIC DIRECTION OR DIRECTIONS, OUR FIGHTER AIRCRAFT MAY NOT BE IN A POSITION FROM WHICH THEY CAN INTERCEPT.

WHAT CAN THE DEFENDER DO TO RESPOND TO THESE TACTICS AND SYSTEM IMPROVEMENTS BY THE ATTACKER? AS I SEE IT, HE HAS TWO PRINCIPAL RECOURSES. HE CAN ATTEMPT TO MAKE THE FIGHTER AIRCRAFT MORE CAPABLE, EITHER BY INCREASING AIRCRAFT PERFORMANCE (LONGER RANGE, INCREASED TIME-ON-STATION, FASTER SPEEDS) OR INCREASING THE WEAPON CAPABILITY OF THE AIRCRAFT (LONGER RANGE MISSILES, CARRY MORE MISSILES), OR BOTH. THIS IS SOMETHING WE HAVE BEEN DOING CONTINUALLY. HOWEVER, THERE ARE REAL CONSTRAINTS ON OUR ABILITY TO INCREASE FIGHTER

PERFORMANCE. MOST OF THESE HAVE TO DO WITH THE FACT THAT THE FIGHTER AIRCRAFT ARE BASED AT SEA ON AIRCRAFT CARRIERS. THIS LIMITS THE SIZE AND WEIGHT OF THE FIGHTERS. THE F-14 IS A VERY CAPABLE FIGHTER AIRCRAFT THAT WILL BE IN THE FLEET FOR MANY YEARS. WHAT HAS TO BE DONE IS TO INCREASE OUR ABILITY TO BRING THOSE VERY CAPABLE AIRCRAFT TO BEAR.

THIS CAN BE DONE BY INCREASING OUR DETECTION CAPABILITY-- THAT IS, PROVIDE EARLY WARNING OF THE ATTACK. THIS GIVES THE DEFENDER MORE TIME TO RESPOND AND MORE TIME TO POSITION HIMSELF OPTIMALLY FOR THE ATTACK.

PROVIDING EARLY WARNING OF IMPENDING ATTACK IS THE SINGLE MOST IMPORTANT THING THAT WE CAN DO TO IMPROVE OUTER-AIR DEFENSE.

SLIDE 9 OFF

SLIDE 10 ON

NOW LET ME TURN TO THE SECOND DEFENSIVE FUNCTION OF THE OUTER-AIR DEFENSE--DEFENSE AGAINST MANY ATTACKERS. HERE THE PROBLEM IS TO MASS OR INCREASE YOUR FIREPOWER. THIS CAN BE DONE BY INCREASING THE ENGAGEMENT CAPACITY OF EACH FIGHTER. ONCE AGAIN THERE ARE SEVERE LIMITS ON OUR ABILITY TO CONTINUE INCREASING INDIVIDUAL UNIT FIREPOWER. OUR ANALYSES SHOW US THAT WHAT IS REALLY NEEDED IS THE ABILITY TO GET NUMEROUS FIGHTERS IN A POSITION TO MEET THE ATTACK. THIS IS DIFFICULT. IN ORDER TO DEFEND SUCCESSFULLY

AGAINST A SINGLE ATTACKING AIRCRAFT, FIGHTERS MUST BE STATIONED AT LONG RANGES FROM THE TASK FORCE CENTER. THAT MEANS A WIDE PERIMETER MUST BE COVERED. HENCE, FIGHTERS, LIMITED IN NUMBERS BECAUSE OF THE DECK CONSTRAINTS OF THE AIRCRAFT CARRIER, ARE SPREAD THINLY.

THE SOLUTION TO THIS IS THE SAME AS BEFORE--EARLY WARNING. IF WE CAN DETECT THE DIRECTION OF THE ATTACK THEN WE CAN TAKE STEPS TO POSITION OUR FIGHTERS ACCORDINGLY.

EVEN AS I SAY THIS, YOU OUGHT TO BE THINKING OF WHAT COUNTERMEASURES THE ATTACKER CAN USE AGAINST OUR EARLY WARNING SYSTEM.

SLIDE 10 OFF

SLIDE 11 ON

NOW TO THE FINAL DEFENSIVE FUNCTION OF THE OUTER-AIR DEFENSE--DEFENSE AGAINST REPEATED ATTACKS. THIS IS RATHER STRAIGHTFORWARD, BUT IN MY VIEW THE LEAST EMPHASIZED OF ALL THE DEFENSE FUNCTIONS. IT WILL BECOME MORE IMPORTANT AND MORE CRITICAL IN THE FUTURE.

FIRST OF ALL, WE MUST BE SUCCESSFUL AGAINST THE INITIAL ATTACK BEFORE WE CAN WORRY ABOUT REPEAT ATTACKS. THIS DOESN'T NECESSARILY MEAN THAT WE DESTROY ALL THE ATTACKERS, BUT IT DOES MEAN THAT WE



SURVIVE SUFFICIENTLY TO MUSTER A VIABLE DEFENSE ON SUBSEQUENT ATTACKS.

SECOND, THE FORCE MUST BE ABLE TO RECOVER IN TIME FOR SUBSEQUENT ATTACKS--THAT IS, IT MUST CATCH ITS BREATH. THIS FOCUSES ATTENTION ON A DIFFERENT ASPECT OF THE DEFENSE PROBLEM--THE SUPPORT OF THE DEFENDER. AIRCRAFT RELIABILITY AND MAINTAINABILITY BECOME CRITICAL. WEAPON INVENTORY BECOMES CRITICAL--DO WE HAVE ENOUGH RELOADS? THE TEMPO OF FLIGHT OPERATIONS AND THE FREQUENCY WITH WHICH WE HAVE TO DEFEND AFFECT CREW FATIGUE WHICH INFLUENCES OUR ABILITY TO RECOVER.

SLIDE 11 OFF

SLIDE 12 ON

THE SECOND LAYER OF DEFENSE FOR AIRCRAFT CARRIER BATTLE GROUPS AND THE FIRST LAYER FOR ALL OTHER NAVAL FORCES IS THE AREA DEFENSE. THE PURPOSE OF THE AREA DEFENSES IS TO REDUCE THE NUMBER OF ATTACKING MISSILES TO A LEVEL THAT POINT DEFENSES CAN ADEQUATELY DEFEND AGAINST. THESE DEFENSES ARE DESIGNED SO THAT THEY CAN, IDEALLY, PROVIDE A DEFENSIVE UMBRELLA FOR MANY SHIPS--HENCE, THE NAME "AREA" DEFENSE.

THE ELEMENTS OF THIS DEFENSE LAYER ARE SURVEILLANCE RADARS TO DETECT THE ATTACK, WEAPON CONTROL OR FIRE CONTROL RADARS TO DIRECT THE DEFENDER'S WEAPON SURFACE-TO-AIR MISSILES,

OR SAMs. OF COURSE, I'VE LEFT A NUMBER OF IMPORTANT ELEMENTS OUT OF THIS LIST--THE DECISION AND CONTROL APPARATUS THAT LINKS THESE ELEMENTS TOGETHER, AND THE LAUNCHING SYSTEMS FOR THE SAMs. THE AREA DEFENSE SYSTEMS NOW IN THE FLEET ARE THE TARTAR AND TERRIER SYSTEMS THAT USE THE SM-1 MISSILE. IN THE FUTURE WE WILL HAVE IMPROVED VERSIONS OF THESE OLDER SYSTEMS AS WELL AS THE AEGIS WEAPON SYSTEM.

SLIDE 12 OFF

SLIDE 13 ON

LET'S TURN TO THE FIRST DEFENSIVE FUNCTION FOR AREA DEFENSE. THIS IS THE SAME TYPE OF TIME-RANGE DIAGRAM THAT WE SAW BEFORE. THE LINE RUNNING FROM RIGHT TO LEFT INDICATES THE PATH OF THE ATTACKING MISSILE. IT CONTINUES TO AN IMPACT OR DETONATION POINT AT THE TASK FORCE.

OVERLAY 1 ON

THE DEFENDER'S TASK IS ILLUSTRATED HERE. HE MUST DETECT THE ATTACKER, REACT, AND FIRE A SURFACE-TO-AIR MISSILE TO INTERCEPT THE ATTACKING MISSILE. THE INTERCEPT MUST TAKE PLACE IN A PARTICULAR INTERCEPT REGION. THIS MERELY INDICATES THE REGION IN WHICH INTERCEPTS ARE PHYSICALLY POSSIBLE. THIS REGION DEPENDS ON THE RELATIVE CHARACTERISTICS OF THE ATTACKING MISSILE (ITS SPEED, SIZE, AND TRAJECTORY) AND THE SAM (ITS SPEED,

MANEUVERABILITY, AND WARHEAD).

HERE I'VE SHOWN A FEASIBLE INTERCEPT. IF THE INTERCEPT WERE NOT SUCCESSFUL, THEN, TIME PERMITTING, WE MIGHT TRY A SECOND INTERCEPT. (DASHED LINE)

OVERLAY 2 ON

IN THE CASE I'VE SHOWN HERE A SECOND INTERCEPT IS NOT POSSIBLE. WHY? BECAUSE WE DIDN'T HAVE ENOUGH TIME.

SLIDE 13 OFF

SLIDE 14 ON

AS IN THE OUTER-AIR DEFENSE, TIME IS THE CRITICAL FACTOR. THE ATTACKER ATTEMPTS TO REDUCE THE TIME AVAILABLE BY CHANGING MISSILE TRAJECTORY, INCREASING THE SPEED OF HIS MISSILES, AND JAMMING OUR DETECTION SYSTEMS. THE DEFENDER CAN RESPOND BY REDUCING THE REACTION TIME--THE MOVE TO AUTOMATED, COMPUTERIZED SYSTEMS IS VASTLY IMPROVING OUR REACTION TIME. WE CAN INCREASE THE SPEED OF OUR SAMs, AND REDUCE THE SUSCEPTIBILITY OF OUR RADARS TO JAMMING.

IN THE LAST DECADE WE HAVE SPENT A LOT OF EFFORT IN DEVELOPING SYSTEMS SUCH AS AEGIS THAT HAVE VERY GOOD REACTION TIMES AND GOOD PERFORMANCE AGAINST JAMMING.

SLIDE 14 OFF

SLIDE 15 ON

HAVING MASTERED THE DEFENSE AGAINST A SINGLE ATTACKING MISSILE, WHAT HAPPENS WHEN THERE ARE MANY INCOMING MISSILES. UNLIKE THE OUTER-AIR DEFENSE, MASSING OF THE DEFENDING UNITS, THE SHIPS, IS NOT A PROBLEM. THE AREA DEFENSES THAT THEY CARRY CAN COVER MANY DIRECTIONS OF ATTACK. HOWEVER, APPLYING THAT FIREPOWER EFFICIENTLY IS A PROBLEM.

LET ME SEE IF I CAN'T DESCRIBE THE PROBLEM BY USING AN ANALOGY. CONSIDER TWO SOLDIERS DEFENDING A FORT WITH RIFLES AGAINST ATTACKING INFANTRY. ASSUME THE RIFLES ARE SINGLE SHOT WITH A FAIRLY LENGTHY RELOAD TIME. SUPPOSE THERE ARE TWO ATTACKING SOLDIERS ALSO, BOTH VERY CLOSE TOGETHER. FURTHER ASSUME THAT OUR TWO DEFENDERS CAN'T COMMUNICATE WITH EACH OTHER. THEY HAVE TWO INTERCEPT OPPORTUNITIES (THAT IS, TWO RIFLES WITH ONE SHOT EACH), AGAINST TWO ATTACKERS. EVERYTHING'S OKAY, RIGHT? NOT NECESSARILY; SUPPOSE BOTH OF OUR DEFENDERS FIRE THEIR RIFLES AT THE SAME ATTACKER? WE WILL NOT HAVE USED OUR FIREPOWER EFFICIENTLY, AND AS A RESULT MAY HAVE LOST THE BATTLE. DEFENDING SAM SHIPS HAVE THE SAME PROBLEM, ONLY MORE INTENSIVELY. THERE ARE LIKELY TO BE MANY MORE ATTACKERS THAN DEFENDERS AND THE TIMES ARE PERHAPS EVEN MORE CRITICAL.

HOW CAN WE OVERCOME THIS PROBLEM? IN THE CASE OF OUR TWO SOLDIERS, WE COULD GIVE THEM TWO-SHOT RIFLES. THEN EACH DEFENDER CAN SHOOT ONCE AT EACH ATTACKER. ALTHOUGH THE TWO DEFENDERS ARE STILL NOT ACTING IN CONCERT, EACH INDIVIDUALLY CAN COORDINATE HIS OWN ACTION--THAT IS, ALLOCATE ONE SHOT TO EACH ATTACKER. IN A SIMILAR MANNER WE CAN INCREASE EACH SHIPS' FIREPOWER. THE DEVELOPMENT OF AEGIS IS A SIGNIFICANT STEP IN THAT DIRECTION. RECALL THAT THIS WASN'T A VERY EXCITING CONCEPT IN OUR OUTER-AIR DEFENSE. THE NECESSARY SIZE OF THE FIGHTER AIRCRAFT PLACED SEVERE LIMITS ON OUR ABILITY TO INCREASE UNIT FIREPOWER. ON A SURFACE SHIP THOSE CONSTRAINTS ARE LESS SEVERE.

THERE IS ANOTHER WAY TO OVERCOME THE PROBLEM--THAT IS, TO HAVE EACH DEFENDING UNIT COORDINATE ITS ACTIONS WITH EVERY OTHER DEFENDER. FOR OUR SOLDIERS, WE CAN ALLOW THEM TO COMMUNICATE. FOR EXAMPLE, A SIMPLE COMMUNICATION LIKE "I'LL TAKE THE ONE ON THE LEFT, YOU GET THE ONE ON THE RIGHT" WOULD SOLVE OUR PROBLEM. FOR SAM SHIPS THE COORDINATION COULD BE MORE DIFFICULT, BUT THE CONCEPT IS THE SAME.

COORDINATION OF AAW DEFENSES IS AN IMPORTANT SUBJECT AND ONE THAT IS OF INTEREST NOW. LET'S CONSIDER WHAT IT MEANS FOR OUR DEFENDING FORCE.

SLIDE 15 OFF

SLIDE 16 ON

HERE I PLOT THE NUMBER OF DEFENDING SHIPS ON THE HORIZONTAL AXIS AND THE NUMBER OF ATTACKING MISSILES KILLED ON THE VERTICAL AXIS. THE DASHED LINE INDICATES THE SIZE OF THE MISSILE ATTACK-- A PERFECT AREA DEFENSE, WHICH DOES NOT EXIST, WOULD HAVE TO KILL THAT NUMBER OF MISSILES. THE CURVE INDICATES THE EFFECTIVENESS OF THE DEFENDING FORCE IF EACH DEFENDER ACTS INDEPENDENTLY OF ALL OTHER DEFENDERS. IT CURVES OVER FOR TWO REASONS: SOME DEFENDER EFFORTS ARE WASTED BY OVER-KILLING MISSILES; AND AS MORE DEFENDERS ARE ADDED, IT IS LESS LIKELY THAT ALL WILL BE IN AN OPTIMAL DEFENDING POSITION.

OVERLAY ON

IF THE DEFENSE CAN BE COORDINATED, THE EFFECTIVENESS OF OUR FORCE GOES UP--WE'RE NOT WASTING MISSILES BY OVER-KILLING. OUR MISSILES ARE BEING USED MORE EFFICIENTLY. THIS MEANS THAT NOT ONLY ARE OUR DEFENSES BETTER, WE'RE ALSO USING FEWER SAMs. THIS IS PARTICULARLY IMPORTANT FOR THE THIRD DEFENSIVE FUNCTION-- DEFENSE AGAINST REPEATED ATTACKS.

SLIDE 16 OFF

SLIDE 17 ON

AGAINST REPEATED ATTACKS OUR AREA DEFENSE MUST FIRST BE ABLE TO ENGAGE SUCCESSFULLY THE INITIAL ATTACKS--THAT IS, SURVIVE. IT MUST SURVIVE WITH SUFFICIENT WEAPONS REMAINING TO WITHSTAND THE SUCCEEDING ATTACKS. THUS, WE HAVE AN INCENTIVE TO CONSERVE AMMUNITION. AS WE MENTIONED BEFORE, COORDINATION OF OUR DEFENSIVE EFFORT DOES THIS.

IT'S NOT SUFFICIENT JUST TO HAVE WEAPONS IN THE TASK FORCE--THEY MUST BE IN THE MAGAZINES OF THE DEFENDING SHIPS--NOT IN SUPPLY SHIPS WHERE THEY CAN'T BE USED. THIS GETS US BACK TO THE ASPECT OF LOGISTICS SUPPORT. REARMING MUST BE DONE IN A TIMELY MANNER BY FORCES THAT ARE THEMSELVES SURVIVABLE.

SLIDE 17 OFF

SLIDE 18 ON

LET ME SAY JUST A FEW WORDS ABOUT POINT DEFENSES. THEY ARE VERY SIMILAR TO AREA DEFENSES, EXCEPT THAT THEY ARE THE LAST LAYER OF DEFENSE. ANYTHING SURVIVING THE POINT DEFENSES WILL PRESUMABLY INFLICT DAMAGE ON THE TASK FORCE. IN ADDITION TO SHORT-RANGE SAM SYSTEMS, GUNS ARE A MAJOR PART OF OUR POINT DEFENSE.

POINT DEFENSES HAVE MANY OF THE SAME GENERAL CHARACTERISTICS AND PROBLEMS AS DO AREA DEFENSES EXCEPT THAT THE TIME AND RANGE IN WHICH THEY CAN ACT IS MORE COMPRESSED.

TWO ASPECTS OF POINT DEFENSES ARE INTERESTING AND IMPORTANT ENOUGH TO BE MENTIONED EXPLICITLY. THE FIRST CONCERNS THE OVERLAP OF THE POINT DEFENSE ZONE WITH THE AREA DEFENSE ZONE. POINT DEFENSES GENERALLY START THEIR ENGAGEMENTS OF HOSTILE TARGETS WHEN THOSE TARGETS ARE STILL IN THE ENVELOPE OF OUR AREA DEFENSE SYSTEMS. IF POINT DEFENSES AND AREA DEFENSES ARE FIRING AT TARGETS INDEPENDENTLY OF EACH OTHER, THEN POINT DEFENSES MAY WASTE TIME AND/OR AMMUNITION ENGAGING TARGETS THAT ARE SUBSEQUENTLY KILLED BY AREA DEFENSES. THIS IS EXACTLY THE COORDINATION PROBLEM THAT WE DISCUSSED WITH RESPECT TO AREA DEFENSES. SINCE MOST POINT DEFENSES ARE CHARACTERIZED BY HAVING A FAIRLY LIMITED RELOAD CAPABILITY SUCH WASTAGE OF MISSILES COULD BE CRITICAL. IN FACT, THIS PROBLEM SERVES TO PUT MORE STRESS ON OUR AREA DEFENSES.

THE SECOND ASPECT OF POINT DEFENSES, THAT IS OF CONCERN, IS THEIR ROLE IF THE WAR WE'RE FIGHTING INVOLVES TACTICAL NUCLEAR WEAPONS. SINCE SUCH WEAPONS CAN CAUSE DESTRUCTION AT CONSIDERABLE DISTANCES FROM THEIR INTENDED TARGET, POINT DEFENSES MAY BE USELESS AGAINST THEM. ONCE AGAIN, MORE STRESS IS PLACED ON THE AREA AND OUTER AIR DEFENSES. IN THE CASE OF A TACTICAL NUCLEAR ATTACK LAUNCHED BY SHIPS OR SUBMARINES, WE MAY BE REDUCED TO ONE LAYER OF DEFENSE--THE AREA SAM SYSTEMS.

SLIDE 18 OFF

SLIDE 19 ON



NOW LET ME SUMMARIZE MY CANDIDATES FOR THE MAJOR PROBLEMS FACING EACH OF THE THREE LAYERS OF AAW DEFENSE. IN THE OUTER-AIR DEFENSE, OUR MAJOR PROBLEM IS DETECTING THE DIRECTION AND TIME OF THE ATTACK SOON ENOUGH TO GET OUR FIGHTER AIRCRAFT, F-14s, F-4s, AND F-18s, IN POSITION TO INTERCEPT INCOMING BOMBERS. THAT IS, WE NEED EARLY WARNING OF THE ATTACK.

ONCE WE CAN GET THIS EARLY WARNING, WE NEED TO DEVELOP TACTICS WITH WHICH TO BRING OUR FIGHTERS TO BEAR: HOW MANY FIGHTERS SHOULD WE KEEP AIRBORNE; HOW MANY ON ALERT IN DECK-LAUNCHED INTERCEPTOR STATIONS; HOW SHOULD WE POSITION FIGHTERS; HOW SHOULD THEY COORDINATE THEIR INTERCEPTS; HOW SHOULD WE SUPPORT THE FIGHTERS WITH TANKER AIRCRAFT; AND HOW SHOULD WE DESIGN OUR FLIGHT SCHEDULES TO MAXIMIZE OUR DEFENSIVE POSTURE. WITHOUT THIS TACTICAL DEVELOPMENT, THE ABILITY TO GET EARLY WARNING INFORMATION WILL NOT BE VERY USEFUL.

IN THE AREA DEFENSE LAYER, THERE WILL BE TWO MAJOR PROBLEMS IN THE FUTURE. AS WE POINTED OUT BEFORE, BOTH ARE CLOSELY RELATED. FIRST, IN ORDER TO DEFEND SUCCESSFULLY AGAINST MANY ATTACKERS WE MUST USE OUR DEFENSIVE ASSETS EFFICIENTLY. THAT IS, WE CAN'T WASTE TIME AND AMMUNITION BY ENGAGING THE SAME TARGET WITH MULTIPLE SAM BATTERIES. WE MUST FIND WAYS OF MINIMIZING THIS WASTAGE BY SOMEHOW COORDINATING OUR EFFORTS.

SECOND, IN ORDER TO DEFEND AGAINST REPEATED ATTACKS WE MUST CONCERN OURSELVES WITH THE CONSERVATION OF LIMITED AND COSTLY AMMUNITION. AS WE SAW BEFORE, THIS LEADS ALSO TOWARDS COORDINATION OF OUR DEFENSIVE EFFORTS--TO MINIMIZE WASTE OF SAMs. HENCE, FOR AREA DEFENSE THE BIG PROBLEM IS THE ACHIEVEMENT OF FIREPOWER COORDINATION WITHIN THE AREA DEFENSES.

FOR POINT DEFENSES, AS WE JUST MENTIONED, A MAJOR PROBLEM IS THE POSSIBLE OVERLAP WITH AREA DEFENSE SYSTEMS. THIS AGAIN IS A COORDINATION PROBLEM--THIS TIME BETWEEN LAYERS OF DEFENSE. ALTHOUGH I DIDN'T SHOW IT ON THE SLIDE, THIS COORDINATION IS IMPORTANT TO CONSERVE LIMITED POINT DEFENSE WEAPONS.

BEFORE GOING ON, LET ME POINT OUT WHAT IS PROBABLY OBVIOUS. OUR AAW DEFENSE PROBLEM WILL NOT BE SOLVED BY WORKING ON ANY ONE OF THESE THREE LAYERS OF DEFENSE. WE MUST GET INTO THE HABIT OF VIEWING THIS PROBLEM AS A SYSTEM PROBLEM. THE DESIGN AND EFFECTIVENESS OF EACH LAYER AFFECTS THE DESIGN AND EFFECTIVENESS OF THE OTHER LAYERS.

SLIDE 19 OFF  
SLIDE 20 ON

WHAT ARE THE CHALLENGES TO OUR DEFENSE ESTABLISHMENT AND INDUSTRY IN THE AAW AREA: HERE I LIST THREE. THE FIRST TWO ARE EASY TO WRITE DOWN AND EVERYBODY AGREES ON THEM, BUT THEY ARE OF INCREASING IMPORTANCE.

AS OUR DEFENSE PROBLEM BECOMES MORE STRESSFUL, AAW SYSTEMS ARE BECOMING MORE COMPLEX. UNFORTUNATELY, THIS USUALLY MEANS THAT THESE SYSTEMS ARE ALSO BECOMING MORE EXPENSIVE. YOU MUST STRIVE EVEN HARDER TO DEVELOP SYSTEMS THAT DO THIS JOB IN THE MOST EFFICIENT MANNER.

CONSIDER THE COST OF AAW WEAPONS. WHEREAS IN THE PAST WE USED FAIRLY CHEAP BULLETS FOR AAW DEFENSE, WE ARE NOW USING MISSILES WITH SOPHISTICATED GUIDANCE MECHANISMS, HIGH SPEED, AND HIGH MANEUVERABILITY. OUR LATEST BREED OF SAM, THE STANDARD MISSILE-TWO, COSTS TWO TO THREE TIMES WHAT ITS PREDECESSOR DID-- WE'RE NOW TALKING OF HUNDREDS OF THOUSANDS OF DOLLARS FOR A SINGLE MISSILE. CLEARLY COST IS A MAJOR CONCERN AND A MAJOR CHALLENGE TO THE INDUSTRY.

SECOND, WE MUST DEVELOP SYSTEMS AND TECHNIQUES THAT ARE VERSATILE AND CAN ACCOMODATE CHANGES IN THE THREAT.

THE THIRD CHALLENGE THAT I LISTED HERE IS MY FAVORITE. THROUGHOUT THE PREVIOUS SLIDES, I KEPT MENTIONING THE IMPORTANCE OF COORDINATION. WE ARE PRESENTLY INVESTIGATING WAYS OF ACHIEVING

THIS COORDINATION. TO MY KNOWLEDGE MOST OF THESE CONCEPTS REVOLVE AROUND SOME SORT OF DIRECT CONTROL AND COMMUNICATION SYSTEM. SIMILAR TO THE SOLDIERS IN MY EARLIER EXAMPLE, WHO SAID, "YOU TAKE THE ONE ON THE LEFT, I'LL GET THE ONE OF THE RIGHT." BUT WHAT WOULD HAVE HAPPENED IF THAT COMMUNICATION SYSTEM WASN'T AVAILABLE?

MY PERSONAL CHALLENGE TO THE INDUSTRY IS TO DEVELOP SOME MEANS OF COORDINATING OUR AREA DEFENSES THAT DOES NOT RELY ON DIRECT COMMUNICATION IN THE NORMAL SENSE. I HAVE NO IDEA IF THIS IS POSSIBLE; IT MAY JUST BE A FOND HOPE.

HOWEVER, LET ME INDICATE THE TYPE OF THING I'M THINKING ABOUT BY RETURNING TO MY SOLDIER ANALOGY. SUPPOSE THAT EACH OF THE SOLDIERS DEFENDING OUR FORT HAS A FLASHLIGHT ATTACHED TO HIS RIFLE. THE FLASHLIGHT IS ALIGNED WITH THE BARREL SO THAT WHATEVER A SOLDIER IS AIMING AT IS ILLUMINATED. OTHER DEFENDING SOLDIERS, SEEING THIS ILLUMINATION, WOULD QUICKLY MOVE ON TO NON-ILLUMINATED TARGETS, THUS ACHIEVING COORDINATION WITHOUT DEPENDING ON DIRECT COMMUNICATION BETWEEN DEFENDERS.

WHAT IS NEEDED IS A SIMPLE SCHEME THAT TAKES ADVANTAGE OF THE PHYSICS OF THE SITUATION AND CHARACTERISTICS OF THE ATTACKER AND THE DEFENDER. I DON'T PRETEND TO HAVE ANY ANSWERS AS TO HOW OR IF THIS CAN BE ACHIEVED. IN MY VIEW, IT IS DESIRABLE, HOWEVER.

SLIDE 20 OFF

FINALLY, LET ME RE-EMPHASIZE THE IMPORTANCE OF SOLVING  
ALL THREE FUNCTIONS OF DEFENSE:

- DEFENSE AGAINST AN ATTACKER
- DEFENSE AGAINST MANY ATTACKERS
- DEFENSE AGAINST REPEATED ATTACKS.

WE NEED TO KEEP ALL THREE IN MIND AS WE ATTEMPT TO SOLVE THE  
AAW PROBLEM.

THANK YOU FOR YOUR INDULGENCE. I'D BE HAPPY TO TRY TO  
ANSWER ANY QUESTIONS YOU MIGHT HAVE OR DISCUSS ANY OF THESE  
SUBJECTS WITH YOU.

ANTI-AIR WARFARE DEFENSE  
OF  
SHIPS AT SEA

- OVERVIEW OF AAW DEFENSE
- IDENTIFICATION OF PROBLEM AREAS

FUNCTIONS OF ANY DEFENSE SYSTEM

- DETECT ATTACKING FORCE
- REACT IN TIME
- USE WEAPON EFFECTIVELY
- BRING ENOUGH WEAPONS TO BEAR
- DEFEND AGAINST REPEATED ATTACKS



HIERARCHY OF DEFENSIVE FUNCTIONS

- DEFEND AGAINST AN ATTACKER
- DEFEND AGAINST MANY ATTACKERS
- DEFEND AGAINST REPEATED ATTACKS

AAW THREAT

PRESENT

- MISSILES LAUNCHED FROM AIRCRAFT, SHIPS,  
AND SUBMARINES
- AIRCRAFT

FUTURE

- MORE CAPABLE MISSILES
  - LONGER RANGE
  - SOPHISTICATED GUIDANCE
  - NEW TRAJECTORIES
  - INTENSE JAMMING

## AAW DEFENSES

### HARD-KILL DEFENSES

- OUTER AIR - FIGHTER AIRCRAFT
- AREA - SAM BATTERIES ON SHIPS
- POINT - MISSILE AND GUN BATTERIES  
ON SHIPS

### SOFT-KILL DEFENSES

- AVOID OR DELAY ATTACK
- CONFUSE MISSILE GUIDANCE

## OUTER AIR DEFENSE

### PURPOSE

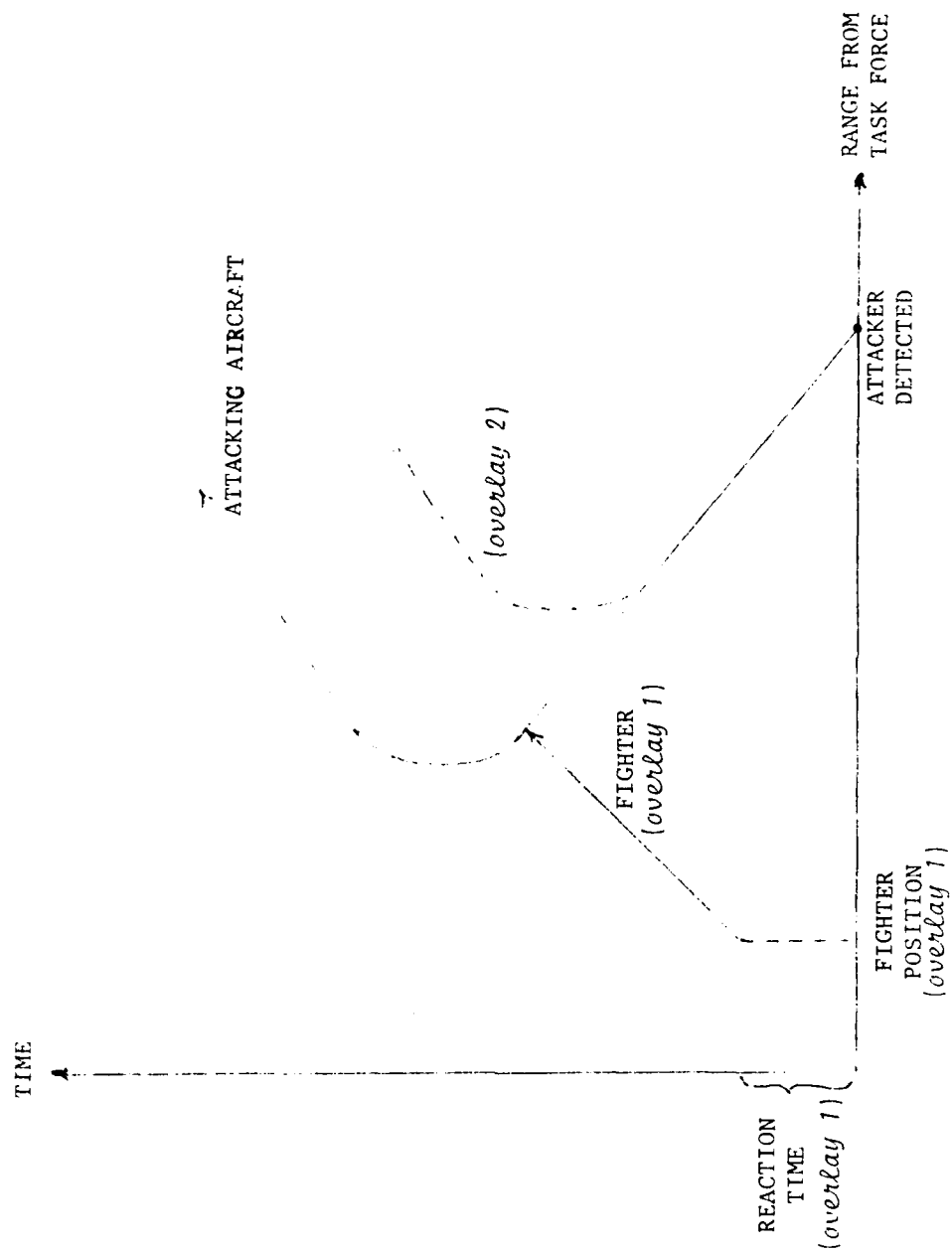
- DILUTE MISSILE ATTACK
- PREVENT REPEAT ATTACKS

### ELEMENTS OF DEFENSE

- AIRBORNE EARLY WARNING AIRCRAFT
- FIGHTER AIRCRAFT

DEFENSE AGAINST AN ATTACKER

OUTER AIR DEFENSE



DEFENSE AGAINST AN ATTACKER

OUTER AIR DEFENSE

- ATTACKER TRIES TO REDUCE TIME AVAILABLE FOR DEFENDING

- INCREASING STANDOFF RANGE
- INCREASING BOMBER SPEED
- JAMMING DETECTION SYSTEMS
- MAKING DIRECTION OF ATTACK UNCERTAIN

- DEFENDER HAS TWO PRINCIPAL RECOURSES

- INCREASE AIRCRAFT/WEAPON PERFORMANCE
- INCREASE DETECTION CAPABILITY (EARLY WARNING)

DEFENSE AGAINST MANY ATTACKERS

OUTER AIR DEFENSE

MASS FIREPOWER

- INCREASE ENGAGEMENT CAPACITY OF  
EACH FIGHTER
- BRING MORE FIGHTERS TO BEAR
  - PROBLEM : WIDE PERIMETER TO COVER
  - SOLUTION: EARLY WARNING

DEFENSE AGAINST REPEATED ATTACKS

OUTER AIR DEFENSE

- MUST BE "SUCCESSFUL" AGAINST INITIAL ATTACK
- MUST RECOVER IN TIME FOR SUBSEQUENT ATTACKS
  - AIRCRAFT RELIABILITY
  - FLIGHT OPERATIONS TENPO
  - CREW FATIGUE
  - WEAPON INVENTORY
  - FIGHTER ATTRITION



## AREA DEFENSE

### PURPOSE

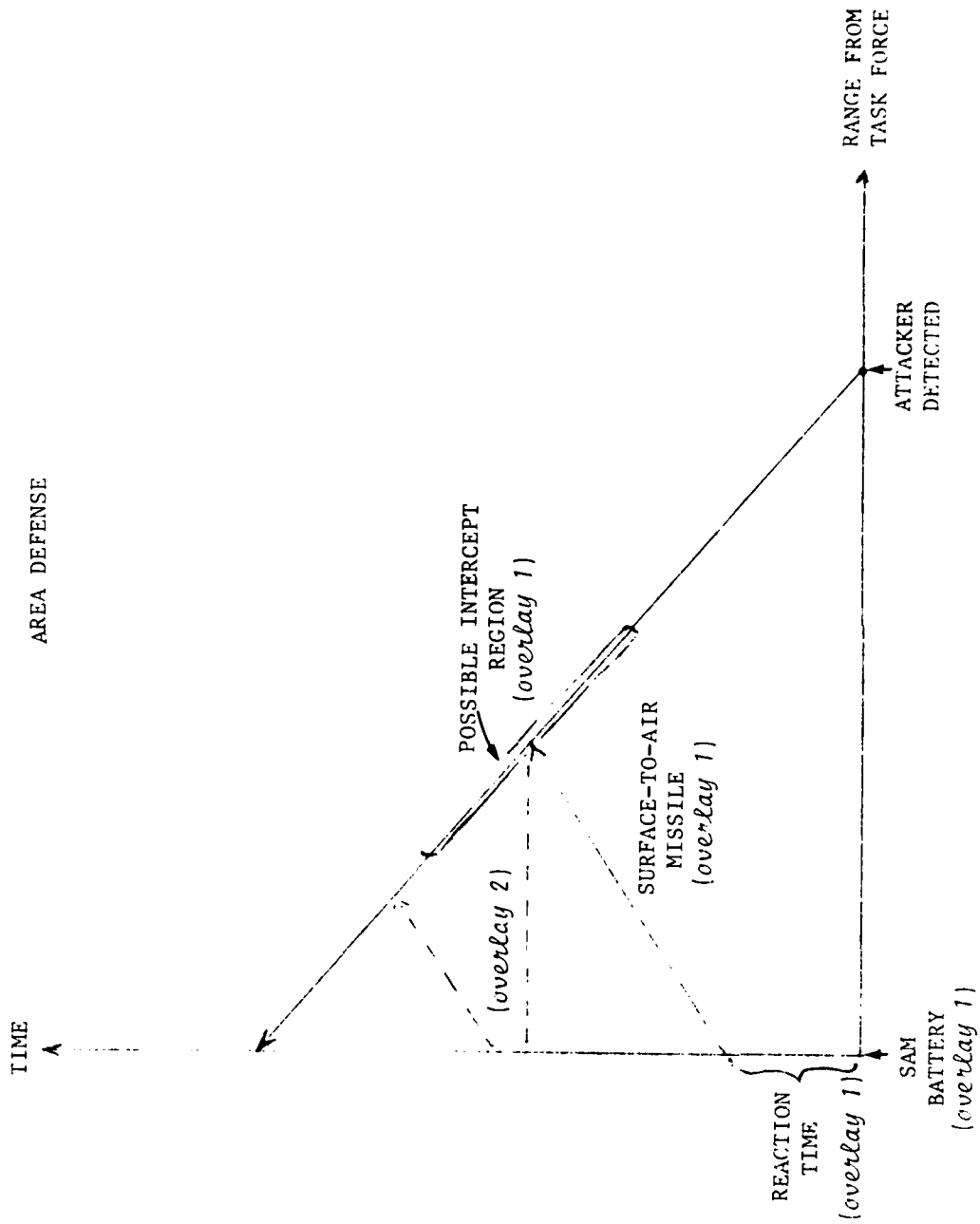
- REDUCE NUMBER OF MISSILES TO LEVEL THAT POINT DEFENSES CAN HANDLE
- PROVIDE DEFENSE UMBRELLA FOR MANY SHIPS

### ELEMENTS OF DEFENSE

- SURVEILLANCE RADARS
- WEAPON-CONTROL RADARS (FIRE CONTROL)
- SURFACE-TO-AIR MISSILES

# DEFENSE AGAINST AN ATTACKER

AREA DEFENSE



DEFENSE AGAINST AN ATTACKER

AREA DEFENSE

- ATTACKER TRIES TO REDUCE TIME AVAILABLE FOR DEFENDING
  - MISSILE TRAJECTORY
  - MISSILE SPEED
  - JAMMING DETECTION SYSTEMS
- DEFENDER CAN RESPOND BY :
  - REDUCING REACTION TIME
  - INCREASING SAM SPEED
  - REDUCING SUSCEPTIBILITY TO JAMMING

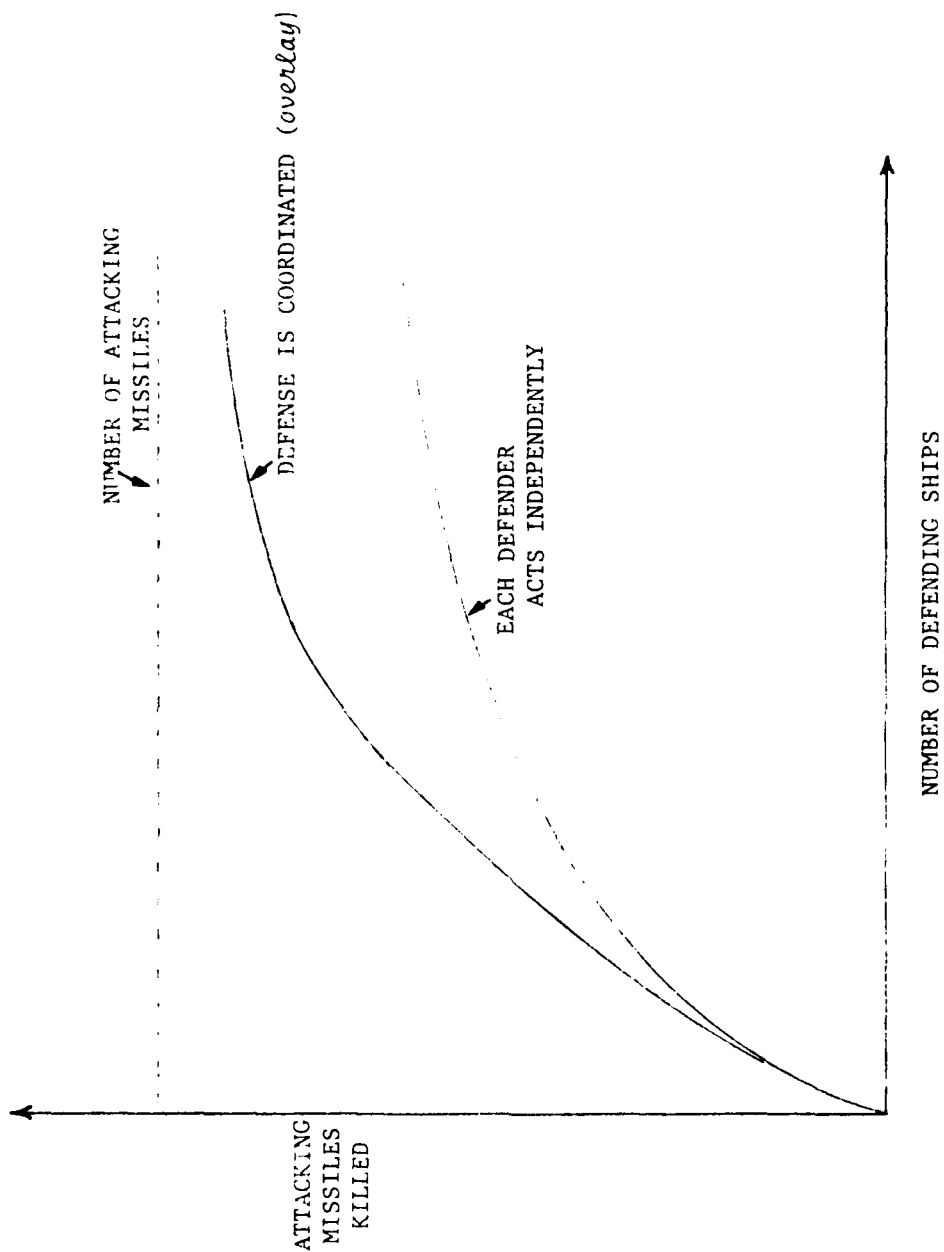
DEFENSE AGAINST MANY ATTACKERS

AREA DEFENSE

- MASSING OF DEFENDING SHIPS NOT MAJOR PROBLEM
- APPLYING SHIPS' FIREPOWER EFFECTIVELY AND EFFICIENTLY IS A PROBLEM
  - INCREASE EACH SHIP'S FIREPOWER
  - COORDINATE ACTIONS OF ALL DEFENDING SHIPS

DEFENSE AGAINST MANY ATTACKERS

AREA DEFENSE



DEFENSE AGAINST REPEATED ATTACKS

AREA DEFENSE

- MUST SURVIVE INITIAL ATTACK
- MUST HAVE SUFFICIENT WEAPON INVENTORY
  - CONSERVATION OF AMMUNITION  
(COORDINATION)
  - DISTRIBUTION OF AMMUNITION  
IN FORCE

# POINT DEFENSES

- SIMILAR TO AREA DEFENSES
- OVERLAP OF POINT DEFENSE ZONE  
AND AREA DEFENSE ZONE
  - COORDINATION
- MAY NOT BE USEFUL IN TACTICAL  
NUCLEAR WARFARE

## MAJOR PROBLEMS

### OUTER AIR DEFENSE

- EARLY WARNING
- TACTICS

### AREA DEFENSE

- EFFICIENT USE OF AVAILABLE FIREPOWER
- CONSERVATION OF LIMITED AMMUNITION

### POINT DEFENSES

- OVERLAP WITH AREA DEFENSES



## CHALLENGES

- DEVELOP SYSTEMS AND TECHNIQUES THAT ARE AFFORDABLE
- DEVELOP SYSTEMS AND TECHNIQUES THAT ARE ROBUST/VERSATILE
- DEVELOP ALTERNATIVE MEANS TO COORDINATE AREA SAM DEFENSES
  - USE OF CENTRALIZED CONTROL AND COMMUNICATION LINKS
  - METHOD INDEPENDENT OF DIRECT COMMUNICATION LINKS

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